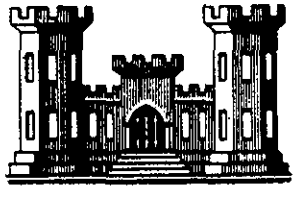
STREAMBANK EROSION CONTROL EVALUATION AND DEMONSTRATION PROJECTS (SECTION 32) IN NEW ENGLAND

HAVERHILL, NEW HAMPSHIRE
NORTHFIELD, MASSACHUSETTS



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

MARCH 1977

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Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts

MARCH 1977

SYLLABUS

Section 32 of the 1974 Water Resources Act (Public Law 93-251), entitled "Streambank Erosion Control Evaluation and Demonstration Act of 1974" has three major provisions; an evaluation of the extent of streambank erosion on the nation's rivers, the development and reporting of new methods of bank protection, and the construction of demonstration streambank erosion control projects at various locations within the United States. This paper deals only with the last of these provisions within the New England area.

Locations of known streambank erosion problems in New England were screened and two sites were identified as being most appropriate for inclusion in the program. These sites were selected because they have a serious erosion problem, they are typical of many miles of eroded bank and because they present an opportunity to experiment with a variety of bank protective techniques.

As with most river banks in New England, the two selected sites are located on private property. The corrective measures which this paper proposes are considered a minimum of protection which can reasonably be expected to perform satisfactorily with a minimum of maintenance or replacement cost.

It should be kept in mind that the project layout and cost estimates were prepared without the benefit of bank or river bottom survey work and without subsurface soils investigations. This investigative work will be undertaken if and when the project sites are approved by the Office of the Chief of Engineers (OCE). The layout and cost estimates will undoubtedly reflect some changes as the work is refined. It is likely that some of the concepts presented in this paper may be changed as more is known about the site. OCE on reviewing this and other efforts throughout the United States may suggest modifications in the techniques which are presented herein.

Cooperation of the property owners, communities and states involved has been excellent. At this time the New England Division is awaiting OCE project approval before formalizing local assurances.

The New England Division, contingent upon project funding, is prepared to initiate engineering and design work in the summer or fall of 1977. Project construction could be accomplished in the spring and summer of 1978.

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FIGURE

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PLATES

STREAMBANK EROSION CONTROL

EVALUATION AND DEMONSTRATION PROJECTS (SECTION 32)

A. GENERAL

Work began in April 1976 on this program which is being carried out under the authority of Public Law 93-251, Section 32. The act provides for the updating of the 1969 National Streambank Erosion Survey, but more importantly the Act provides for the construction of Demonstration Streambank erosion projects throughout the United States.

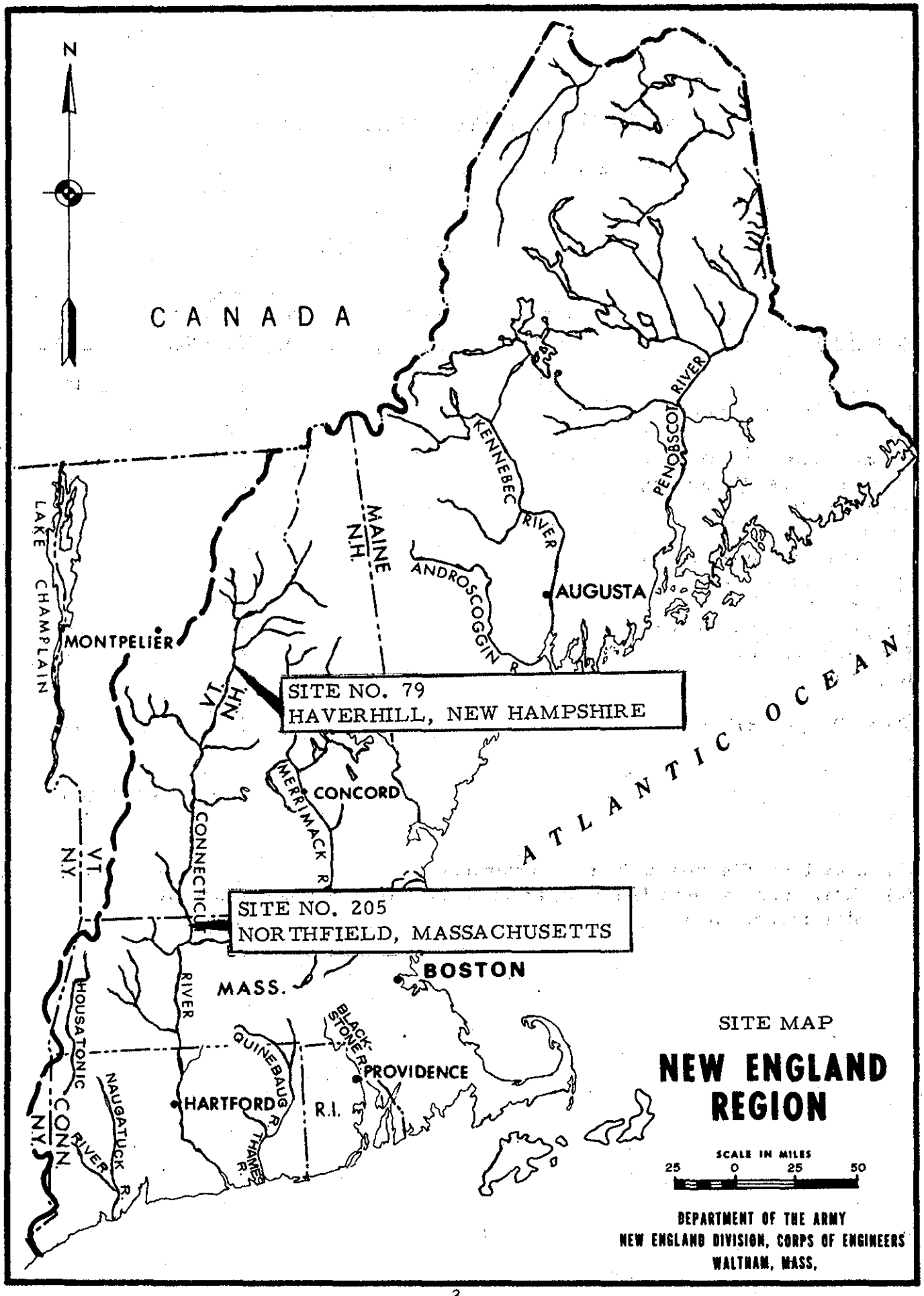
Two project sites, shown on Figure 1, have been tentatively selected in New England. Both sites are on the Connecticut River, one in Haverhill, New Hampshire, the other in Northfield, Massachusetts. The sites are located on private property and were selected because they are considered representative of many miles of streambank erosion in New England. Final selection of the sites depends, of course, on the cooperation of the affected landowners, communities and States.

Generally speaking, each of the sites contains about 2,000 feet of actively eroding streambank. The projects would consist of subdividing each site into several sub-sections, 250-500 feet long. A different bank protective technique would be installed in each test sub-section. Vegetative cover, and various types of mechanical toe protection have been proposed.

The purpose of the project is to experiment with new and perhaps innovative techniques of streambank protection. Techniques which are least expensive to install will be given particular attention. This latter point is important because the project is to demonstrate methods that would also be suitable for local implementation utilizing their own resources.

The present schedule calls for engineering work to begin late next summer and continue through the winter. Construction is planned for the spring of 1978. The projects would be monitored until 1981 when they would be turned over to local authorities for operation and maintenance. Total project costs are estimated at $585,000. The cost breakdown shown on Table 1.

Aside from the actual construction of these experimental projects, there is much to be learned by observing what others have done and are doing in the area of streambank erosion control. Accordingly, it has been decided that the Corps will monitor certain corrective measures installed at local initiative. The Corps', New England Division, intends to monitor two existing projects and two projects which are underway. The specifics of this phase of the work are discussed later on in this report.


N
CANADA
KENNEBEC RIVER
PENOBSCOT RIVER
MAINE
N.H.
ANDROSCOGGIN R.
AUGUSTA
LAKE CHAMPLAIN
MONTPELIER
VT.
N.H.
SITE NO. 79
HAVERHILL, NEW HAMPSHIRE
ATLANTIC OCEAN
MERRIMACK R.
CONCORD
CONNECTICUT
VT.
N.Y.
SITE NO. 205
NORTHFIELD, MASSACHUSETTS
BOSTON
MASS.
HOUSATONIC RIVER
BLACKSTONE R.
QUINEBAUG R.
PROVIDENCE
HARTFORD
R.I.
THAMES R.
CONN.
N.Y.
NAUGATUCK R.
SITE MAP
NEW ENGLAND REGION
SCALE IN MILES
25 0 25 50
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NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

FIG. 1

TABLE 1

PROJECT COST ESTIMATE - SUMMARY

(in $ thousands - June 1976 price level)

Line Item	Time Frame: Planning Phase	Engineering Phase	Construction and Project Monitoring	Total
Planning	$ 2[1]	8	30	$ 40
Hydrology & Hydraulics	6	2	30	38
Surveys	13	-	18	31
Foundations & Materials	21	10	25	56
Design & Cost Estimating	8	30	21	59
Real Estate	9	2	-	11
Legal	-	2	-	2
Construction (Assistance prior to construction contract)	-	2	-	2
Project Construction Cost	-	-	320	320
Special Studies	4	3	10	17
Reports	2	2	5	9
Total Project Effort	65	61	459	585

or $585,000[2]

(1) Line Item Figures Include All Overhead
(2) Total does not include the updating of the National Assessment of Streambank Erosion

B. NARRATIVE REPORT

1. Selection of Test Sites - Two hydraulically dissimilar sites, representative of conditions typical of many large rivers in New England, have been selected to test several methods of streambank protection. The two sites are distinguished from one another in that one is influenced mainly by conditions typical of a naturally flowing, meandering river, whereas at the other location the backwater and water level fluctuation effects of a run-of-the-river power dam are the controlling influences. Both sites are in the flood plain of the Connecticut River which is composed mostly of a silty fine sand in the lower stratum overlain by clayey sandy silt. The first site, located in Haverhill, New Hampshire and identified as Area 79 (see photographs) was selected because it is situated on the outside of a channel bend and is greatly affected by high local velocities and eddies under natural conditions.

The second site, located in Northfield, Massachusetts, is identified as Area 205 (see photographs). This area was selected as it is on a straight reach of channel and is affected by both normal channel velocities and pool stage fluctuations caused by a downstream power dam. Hydrologic, hydraulic and soil data gathered in the ongoing "Connecticut River Streambank Erosion Study" played a significant role in the selection of these sites. Numerous field investigations have already been made of the 140-mile reach of the Connecticut River which includes both Areas 79 and 205. Finally, both sites are located within a 3-hour drive from the New England Division office, making them relatively easy to monitor.

2. Complete Descriptions of the Selected Sites

a. Area 79 - Haverhill, New Hampshire

(1) General Description - Area 79 is located in Haverhill, New Hampshire, about one mile downstream from the Newbury-Haverhill bridge, as shown on plate 1. This actively eroding streambank extends to a height of 5 to 15 feet above the normal water surface and is approximately 2,000 feet long. Although this site is located in the upper reach of the pool formed by the Wilder hydroelectric dam, it is significantly affected by open channel flow conditions. The study reach is at the outside of a 70 degree bend in the Connecticut River.

SITE NO. 79-HAVERHILL, NEW HAMPSHIRE

SITE NO. 79-HAVERHILL, NEW HAMPSHIRE

SITE NO. 205-NORTHFIELD, MASSACHUSETTS

(2) Hydrologic Conditions - Flow conditions at Area 79 are best represented by the records of the U. S. Geological Survey gage located 11 miles upstream on the Connecticut River at Wells River, Vermont (drainage area = 2,644 square miles). The average flow at the gage during the summertime low flow season (July-October) is 3,450 cfs and during the spring snowmelt months (April-May) is 15,635 cfs. The average annual peak discharge has been 33,100 cfs since completion of the last major upstream storage project in 1961. During such an event, high flows overtop the banks which is typical of the upper reach of the Connecticut River. At this particular site, high flows have passed over the top of bank, running down through an adjacent hayfield and rejoined the river at the next channel bend. The river is attempting to create an oxbow which would result in 30 acres of farmland being turned into an island.

The annual mean flow is 4,810 cfs; however, during the day flows may fluctuate from 1,000 to 6,000 cfs due to the operation of upstream power dams. During such normal flow periods the water surface at Area 79 varies from 1 to 1-1/2 feet per day between elevations 386 to 383 feet msl over the weekly period. Under normal flow conditions, local velocities at the toe of the bank have been computed to vary from 0 to 2 fps. During a high flow of approximately 15,000 cfs a toe velocity of 4 fps was measured by a current meter.

(3) Soil Conditions - When inspected on 21 April 1976, the banks ranged from approximately 10 feet above to 3 feet below the water level. The top two-thirds of the exposed banks, except for a foot of sandy silt on the top, consist of a silty medium to fine sand. The lower one-third of the bank is a clayey sandy silt. In the low reaches of the bank, the river had flooded an area around 200 feet across, extending from 150 to 300 feet from the bank. Fresh deposits of silty fine sand varying in depth from a fraction of an inch to several inches were evident along low portions of the entire field.

(4) Protective Measures - It has been observed that during high flows, streamflow is projected against the bank, causing the soil at the toe of the slope to erode. As a result of the removal of this toe material, the bank becomes unstable and large clumps of the upper bank materials break away. An attempt will be made at this area to show the effects local velocities have on the following types of toe protection: (a) 9-inch thick, rockfilled gabion mattress, (b) concrete-filled fabric, and (c) wire mesh and cloth material anchored to the slope. One portion of the reach will not have toe protection. To prevent sloughing of the upper

bank, grass and sod will be used on natural and 1 on 2 cut slopes. In addition, the wire mesh and cloth protection will be extended to the upper slope. Refer to plates 2 and 4 for typical cross sections and plan view layouts, respectively, for each type of protection. Detailed descriptions of each type of protective measure are provided in Section 3.

b. Area 205 - Northfield, Massachusetts

(1) General Description - This area, located on the east bank of the Connecticut River in the town of Northfield, Massachusetts just south of the Route 10 highway bridge, is shown on plate 1. It is situated about midpoint in the 20-mile long Turners Falls power pool. This actively eroding streambank is approximately 15 feet high, 2,000 feet in length, and lies within a straight section of the 600-foot wide river channel. Stream velocities along the bank were observed to be 2 to 3 fps during a high flow of 50,000 cfs.

(2) Hydrologic Conditions - Flow conditions at Area 205 are best represented by the records of the Turners Falls gage (DA= 7,163 square miles). However, data from the 60-year period of record does not reflect the daily flow fluctuations resulting from the operation of the Northfield Mountain Pumped Storage Project which was completed in October 1972. The Northfield Mountain outlet conduit,which is used to exchange water with Turners Falls pool, is located 5 miles downstream from the Area 205 pilot site. The mean summertime flow (July - October) at Turners Falls was 5,700 cfs and the mean spring flow (April-May) was 31,460 cfs. The average annual peak flow has been 71,500 cfs since 1961, the date of final construction of all major upstream storage reservoirs. During annual mean flow conditions, Turners Falls pool fluctuates about 2 feet per day and over a weekly period varies between elevations 180 and 186 feet msl, depending on the power operation of Turners Falls dam, Northfield Mountain Project and upstream power projects.

(3) Soil Conditions - This area is located along fertile farmland of the mid-Connecticut River flood plain. The tree-lined bank is composed of approximately 1 to 2 feet of clayey sandy silt above a stratum of silty fine sand.

(4) Protective Measures - It is believed that if the toe protection holds at the Area 79 pilot site, then it will also hold at Area 205 where the local velocities are much lower. For this reason only one section of this reach will have a heavy toe protection, the 9-inch thick gabion mattress. The wire mesh and cloth material, a lighter and less expensive type of toe protection, will also be tested. The remainder of the reach will have

no toe protection. Due to the presence of many trees, most of the upper bank will be kept to a natural slope and only a 500-foot reach will be cut back to a 1 on 2 slope. Sod, grass and willow trees will be planted on the upper bank to prevent sloughing. In addition, wire mesh and cloth over topsoil and seed will be used to attempt to anchor the upper slope. Refer to plates 2 and 5 for the layout and typical cross sections of each protective measure respectively. Detail descriptions and costs (June 1976 price level) of each scheme are presented in the following paragraphs.

3. Description of Types of Protection

a. Typical cross sections of adopted protection types are presented on plate 2, and detailed descriptions of each type are given below. These protection types are layed out in either 250 or 500 foot reach lengths.

The project layout and cost estimates may change as the work is refined. It is likely that some of the concepts presented may be changed as more is known about the site. It is also quite possible that the Office of Chief of Engineers on reviewing this and other projects throughout the United States may suggest modifications in the techniques which are presented.

(1) Section A-A - Trimming and grading the natural slopes to fill in holes and removal of overhangs to form a good base for grass sod will be done from the normal pool elevation to top of bank. No work will be done in this section below water level (cost: $32.20 per linear foot).

(2) Section B-B - This section will be similar to A-A except that the banks will be covered with 6 inches of topsoil and seeded (cost: $15.20 per linear foot).

(3) Section C-C - The natural slope will be cut back to a 1 on 2 slope starting from the normal water elevation. The slope will then receive 6 inches of topsoil and seed, with scattered willow tree plantings along the bank. There will be no work below the waterline (cost: $45.54 per linear foot).

(4) Section D-D - As in C-C, this section will also be graded to a 1 on 2 slope from the normal water elevation but will just receive grass sod as a final treatment (cost: $49.00 per linear foot).

(5) Section E-E - This section will provide treatment of the bank similar to that in B-B. In addition, wire mesh overlaying a filter cloth will be placed over the entire bank from the toe to the top. This material will be anchored at the toe by the use of a 3 x 3 foot rock-filled gabion running the length of the trial reach and by 4-foot anchors placed 6 feet on center from near the water surface to the top of the bank (cost: $81.10 per linear foot).

(6) Section F-F - Individual gabion mattresses 8' x 6-1/2' x 9" will be layed on the natural slope and laced together in the zone between the toe of the slope and 3 feet above the normal water elevation. These gabions are made of a 2-inch, or smaller, opening wire mesh filled with 2 to 6 inch stone. The rest of the slope will receive a treatment similar to B-B, except that it will begin 3 feet from the normal water elevation at the top of the gabion mattress (cost: $70.60 per linear foot).

(7) Section G-G - This section is similar to F-F type protection, except that A-A type treatment will be used on the upper slope instead of B-B (cost: $87.60 per linear foot).

(8) Section H-H - A double-walled nylon fabric, similar or equal to that manufactured under the trade name "Fabriform", will be used on the natural slope from the toe to 3 feet above the normal water surface elevation and then injected with a fine grained concrete to form the toe protection for this section. Above this the natural bank will be cut to a 1 on 2 slope and finished with 6 inches of top soil and seeded (cost: $98.30 per linear foot).

(9) Section I-I - This section also uses H-H type toe protection. However, the upper bank protection will be similar to the D-D type, except that it begins at the top of the fabriform (cost: $116.20 per linear foot).

b. Other types of protection considered but not adopted in this pilot project are presented in cross section form on plate 3.

C. LOCAL ASSURANCES

The Division of Waterways, under the Executive Office of Environmental Affairs,is the agency in the Commonwealth of Massachusetts that will provide the local assurances. The Director was contacted by phone and the project was explained. The Director indicated his interest verbally. The Corps sent a follow-up letter so that this interest could be documented. A draft agreement of local assurances has been prepared and finalization of this agreement awaits site approval of the Office of the Chief of Engineers (OCE). This agreement will require the signature of the Governor.

The Northfield, Massachusetts project area is in one ownership. The landowner has been contacted and appears anxious to see the project get underway. Entry rights were secured from the landowner so that survey and soils exploration work can begin.

The New Hampshire Water Resources Board will provide the local assurances for the Haverhill, New Hampshire project area. The Chairman was contacted by phone and indicated a strong interest in the project. A follow-up letter was written to the Chairman so that the Board's interest can be documented. A draft agreement of local assurances has been prepared and finalization of this agreement awaits site approval of OCE. The Water Resources Board will forward the agreement to the Governor for signature. The process can be expected to take two to three months from initiation to completion.

One ownership is involved in Haverhill, New Hampshire. The owner was visited and the project was explained to him. He seemed very anxious to see the project get underway. The bank along this project area is prime farmland and the landowner has become very concerned about its loss. The landowner signed entry rights to the Corps so that surveys and soils explorations can get underway.

D. RELATIONSHIP TO ON-GOING STUDY

The New England Division has been engaged in the Connecticut River Streambank Erosion Study (CRSES) since early in 1975. This study, authorized by resolution of the House Committee on Public Works, 11 April 1974, was introduced by the New Hampshire Congressional delegation in response to a public desire to have the causes of erosion determined and to have corrective measures investigated.

A public meeting was held in Hanover, New Hampshire on 30 April 1975. Several other, less formal meetings have been held since that date. An intense public interest in streambank erosion has been exhibited and political interest in the study has developed.

The study area encompasses a 141-mile reach on the main stem of the Connecticut River. About 118 miles of the total reach is impounded in four utility-owned, run-of-the-river, hydroelectric ponds. An estimated 400,000 cubic yards of earth or 37 acres of land, annually, are being eroded from the river banks within the study area. The selected Section 32 project sites are within the limits of the CRSES. The Corps is in the process of determining how much of a factor rapid pool fluctuation is in the erosion problem.

Six index study areas have been selected for the CRSES. Topographic surveys have been made along the bank. Sections have been made to the river's thalweg and several sections have been made across the river. Subsurface explorations are now underway and piezometers have been installed at one of the index areas. Localized river velocities will be calculated along with groundwater velocities in the bank. This information, together with soil type will be used to determine what factors are acting to cause the problem.

The CRSES and the Streambank Erosion Demonstration Project (Section 32) will complement one another. Much information has been gathered for the CRSES which will serve the Section 32 effort. Interest has been aroused in the public, and in State and local governments which will also serve the goals of Section 32. The Section 32 project, on the other hand, will provide a tangible example of what can be done to arrest streambank erosion and be valuable to the Corps in formulating and evaluating corrective measures in the CRSES Study.

E. MONITORING OF EXISTING PROJECTS

1. General - Most of the streambank in New England is in private ownership and although erosion is extensive, bank protection works are not plentiful. There are many sporadic attempts to protect short reaches of bank but there are few well thought out and executed protective works. The Corps has constructed several small revetment projects, but generally these have been built strictly to established standards for rock revetments and do not warrant monitoring under Section 32.

There are, however, two existing protective works and two more that are underway which the New England Division feels are worth monitoring. The two existing projects are interesting because they are inexpensively constructed and have apparently done the job with only minor problems. An in-depth analysis of these projects will permit us to determine other situations where similar techniques might be appropriate.

The two projects underway for which monitoring is recommended are somewhat of an experimental nature. The U. S. Soil Conservation Service is experimenting with vegetative bank stabilization in New Hampshire and a private electric utility is conducting a program principally of vegetative measures in an area in Massachusetts. Both of these areas give the Corps an opportunity to analyze and report on new techniques at a minimum of Federal Cost. Neither SCS nor the utility can be expected to provide the detailed analysis and reporting that would be provided under Section 32.

The, Guidelines for Monitoring Demonstrations of Sites, now in draft and being reviewed by OCE and the Section 32 Steering Committee, will provide the guidance for establishing monitoring procedures. Generally speaking, however, the intensity of monitoring will vary for the areas selected. For instance a cursory look at soil conditions and river velocities will probably suffice at an area which is protected by rubber tire revetments, on the other hand, much more sophisticated monitoring of an area consisting of two miles of rock revetment will be necessary. In the latter case we will want to know the cause of several localized failures in a revetment that otherwise seems to have uniform forces acting upon it.

The following paragraphs describe the sites of past or ongoing erosion control efforts which the New England Division plans to monitor.

2. Site No. 1 - Hanover, New Hampshire - A 10,000 foot long reach of the east bank of the Connecticut River was reveted in 1954 by the New England Power Company (NEPCO). The revetment was done in conjunction with the reconstruction of Wilder Dam which is about 2 miles from the downstream limit of the revetment. The dam was reconstructed in the 1950's at a site about 3/4 mile downstream of the original site and the full operating pool was established 15 feet higher at elevation 385.

The property was then, and is now, owned by Dartmouth University. The University insisted that its bank be protected when it ceded flowage rights to NEPCO.

The subject area along with several other smaller reveted areas are mostly inaccessible by land. NEPCO built a small barge from old oil tanks, attached two outboard motors, and placed the revetments from the water. Gravel was loaded onto the barge along with a small dozer. The barge would move to the site and the dozer would push off the gravel bedding. A well graded rock was then placed on the bedding by the same method. Although NEPCO has not yet provided the Corps with job specifications the revetment seems to be what could be considered a reasonable minimum of rock protection. The area is subject to rapid pool drawdown during the summer months. Wilder Pool impounds only about 0.2 inches of storage and looks and behaves much like a free flowing river in the spring with high river velocities. In the more than 20 years that the revetment has been in place it has generally stood up well. There are localized failures, however, which reportedly have occurred in recent years.

The Corps proposes to examine NEPCO's design for the protective works and estimate present day costs of doing a similar job. The revetment will be thoroughly examined to ascertain how well it has stood up through the years. Soil conditions and hydrologic conditions in the area will be examined to determine the stability of the bank and those forces acting upon the bank.

3. Site No. 2 - Thetford, Vermont - The owner of this property on the Connecticut River has placed rubber tires along about 150 feet of bank. The tires are placed within the normal operating range of the hydroelectric pool which is controlled by Wilder Dam some 15 miles downstream. The tires are not tied together but the voids were apparently filled with rounded boulders. Wilder Dam is operated during high flow periods to maintain a minimum pool elevation, however, there is a definite hydraulic control about a mile upstream of Wilder Dam and the normal spring river profile considerably exceeds the normal high water at the site and goes over the protective works. The bank extends about 20 feet vertically above the normal high water and the top of the protective works.

Rubber tires are also used to protect the bank in Orford, New Hampshire several miles upstream on the Connecticut River from the previously mentioned section. The Orford site, while only about 50 feet long, is in a more actively eroding bank. Again the tires are placed in the normally active zone of pool fluctuation. These tires, placed three years ago, are along a bank only about five feet high. The tires are staggered in each lift and interlocked by two vertical steel rods through the hole of each tire. The holes were then filled with a uniformly graded trap rock. Spring high flows greatly exceed the top elevation of this protective work.

These sites will be examined to see how they are constructed. An assessment of the soil and hydraulic conditions will be made to see what forces are acting on the revetment and records will be kept indicating how the project behaves through the monitoring period. A history of maintenance work (if any) will be informative.

4. Site No. 3 - Turners Falls Pool, Massachusetts - Northeast Utilities (NU) constructed a pump-storage electric facility at Northfield Mountain which uses the Turners Falls pool as the lower impoundment. Turners Falls pool was raised 5.5 feet in 1973 to accommodate the pump-storage operation. Streambank erosion began to accelerate in 1973 and this area is one of the most actively eroding reaches of the Connecticut River today. The Corps has submitted a project proposal within the pool for construction under Section 32.

NU acknowledges that much of the problem is a result of power pool operations. The Company has undertaken a $600,000 program of bank stabilization which began this fall with the cutting of trees which are falling into the river. Several particularly bad areas have been armored. The Company plans to hydroseed the cleared areas in the spring of 1977. Hydroseeding is particularly interesting since it is fast, inexpensive, and can be accomplished in areas away from highway access. NU now estimates that hydroseeding will cost in the neighborhood of $3 per running foot of bank ($15,000 per mile).

Corps monitoring of this work would be on a river reach basis since many discontinuous areas of different soil type and hydrologic conditions will be involved. The techniques employed are certainly unique and need evaluation for application in other areas. For instance, the cut trees were removed from the river bank by helicopter and dropped at a central site for grinding. A cost of $12,000 per mile of bank were reported by NU, whereas conventional tree removal would have cost an estimated $20,000

by river barge or $30,000 by land removal. Unique also, are the companies plans to hydroseed. Seed will be applied from a barge on the river. Seed will consist of a mix of grasses, crown vetch, basket willow and brush. The seed will be applied with water, fertilizer, lime, mulch, and a binder. The mix will form a crust which is expected to withstand rain until the grasses germinate and root. Slower germinating but hardier species of grass and brush in the mix will gradually replace the earlier growth.

NU will of course be monitoring the work because of the sizeable investment. Company plans do not, however, include the in-depth monitoring that is necessary to document the success of the program if it is to be recommended for use by others.

The company is enthusiastic to have the Corps get involved in the program, in fact an exchange of river survey information between the Corps and the company has already taken place.

5. Site No. 4 - Haverhill, New Hampshire - The U.S. Soil Conservation Service (SCS) has assisted several farmers in applying vegetative cover to eroding banks. SCS provides the seed and technical information and the landowner (farmer) provides the necessary labor. The New England Division proposes to work closely with SCS and monitor at least two of these areas and prepare a report on the techniques used and their success.

A reach of particularly active bank in Haverhill, New Hampshire was selected by SCS for experiments with several species of grass and willow trees. The downstream half of the study area was planted with seed and young trees. The upper half of the eroded reach was left untreated and is being monitored as the without condition. Various combinations of seed and small trees were applied on 25 foot long test plots. The project has now been underway for three years and some of the larger species are beginning to mature.

A similar program but on a much less active bank was undertaken in Piermont, New Hampshire. Here basket willow was applied on a low bank. The willows were planted in an area which already had a natural grass cover.

Most of the Corps involvement at these sites will consist of periodically inspecting the areas and reporting the success (or lack of success) of the various trial plantings. The record of river flows in the past will

be examined to determine the severity of forces which have acted on the bank. The record will, of course, be maintained throughout the monitoring period.

SCS is maintaining records of this program and will at some time probably issue a report. The New England Division feels, however, that the added detail of monitoring which can be provided under Section 32 will be extremely valuable in getting the most out of the program.

F. FUTURE OF THE PROGRAM

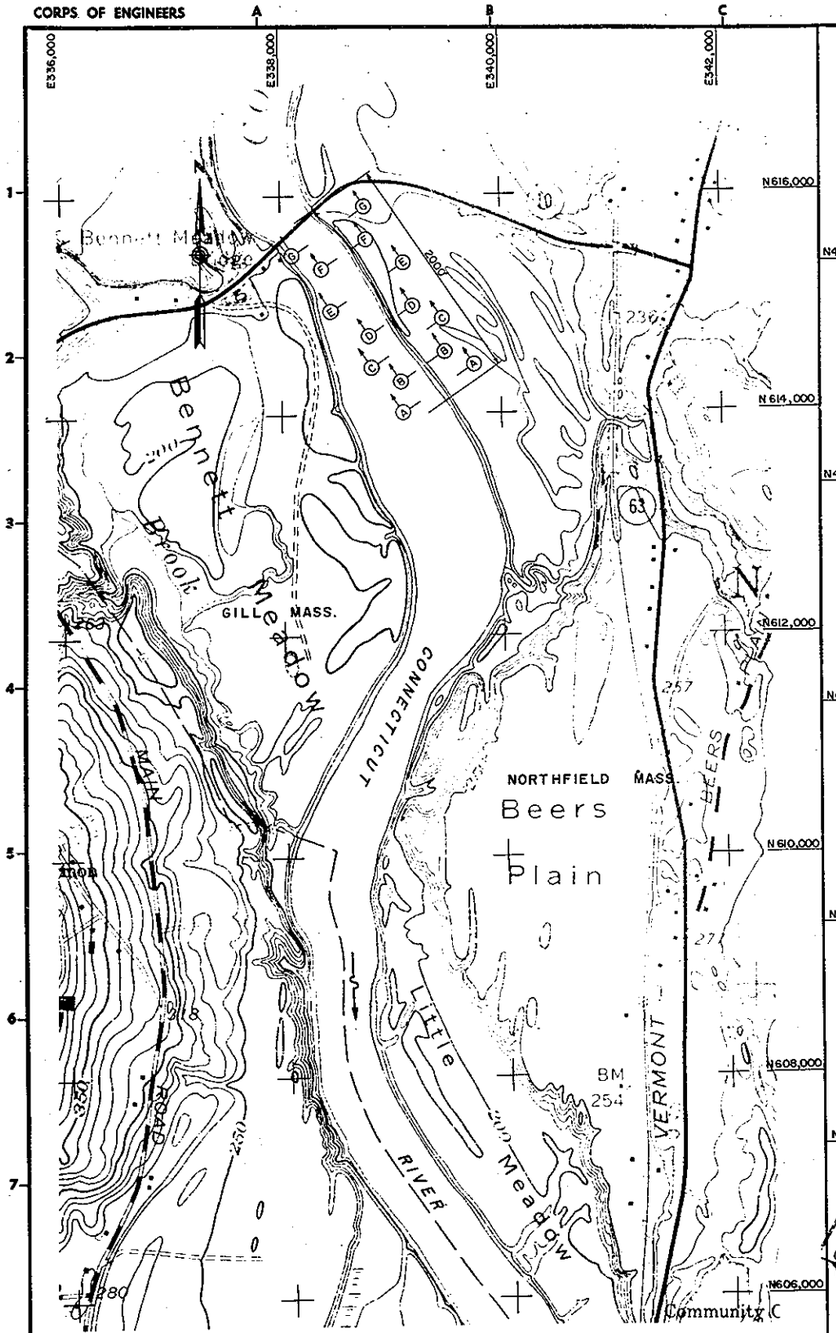
The Corps of Engineers, New England Division (NED) submitted this project proposal to the Office of Chief of Engineers (OCE) in June, 1976. NED is awaiting OCE approval on the project proposal. NED has funds in hand to initiate the next phase of the work but additional funds would have to be provided in FY 1978 to complete the engineering and construction phases of the work.

NED will secure local assurances when the project is approved. Topographic surveys, river cross-sections, and subsurface soils investigations will also get underway. As soon as site data has been gathered, advanced engineering and design work will begin. Construction will follow as soon as possible.

An example of project scheduling can be seen by assuming OCE project approval in April 1977, survey and soils work could be conducted from April to October 1977. Advance engineering and design from October 1977 to March 1978 and construction could be accomplished in the summer of 1978. Project monitoring would continue at least through 1981.

CORPS OF ENGINEERS

U. S ARMY.



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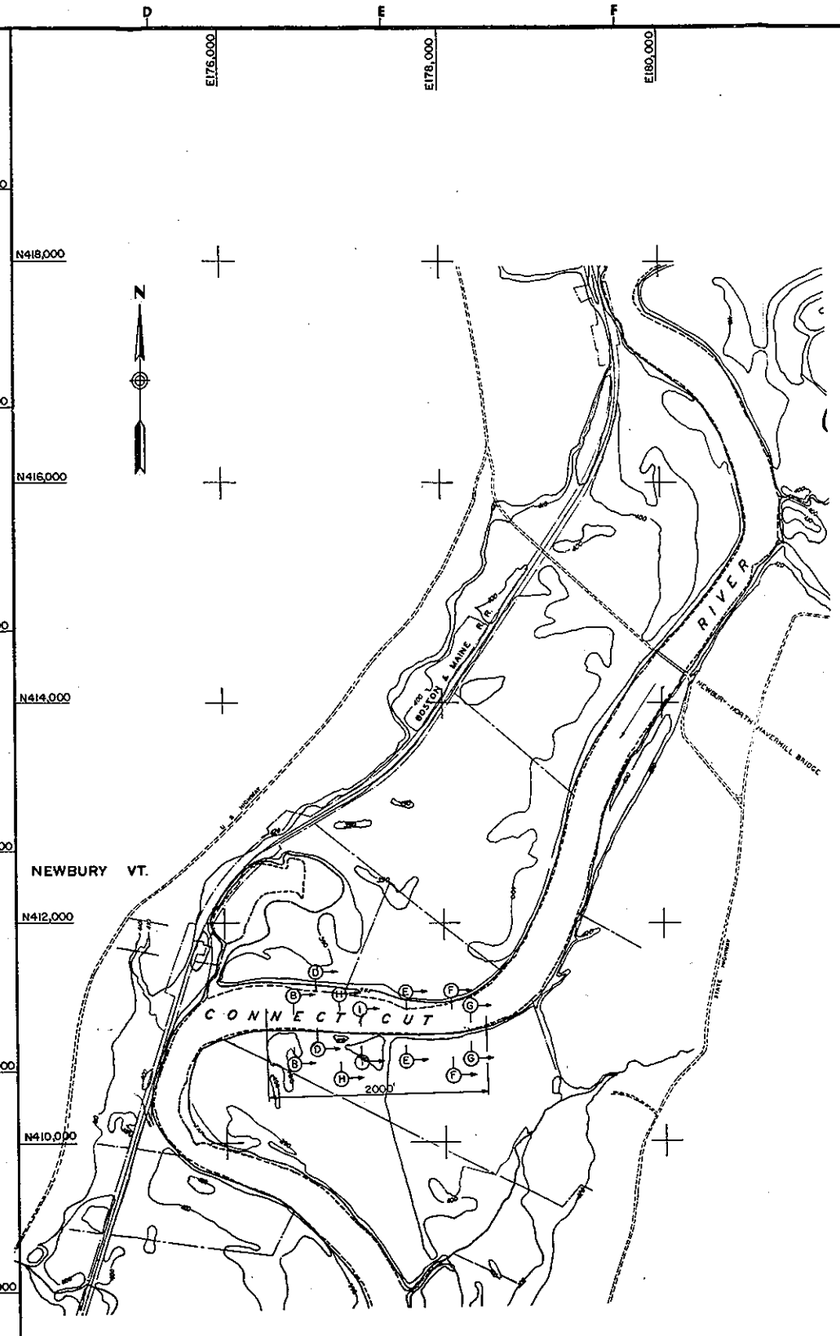

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GRAPHIC SCALE
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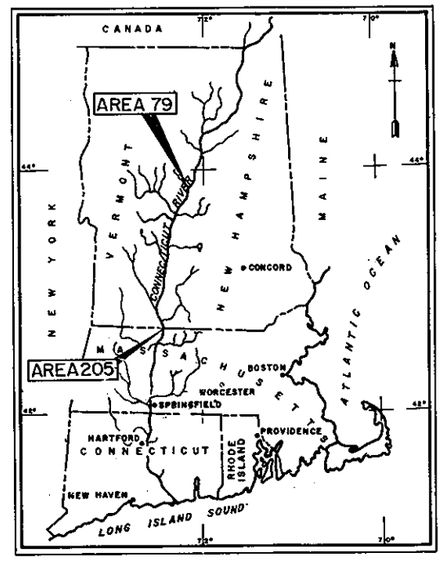


REGIONAL MAP

SCALE
10 0 10 20 30 40 50 MI.

WATER RESOURCES PILOT PROJECT
CONNECTICUT RIVER BASIN
NEW HAMPSHIRE AND MASSACHUSETTS

STREAM BANK EROSION (SECTION 32).
GENERAL PLANS

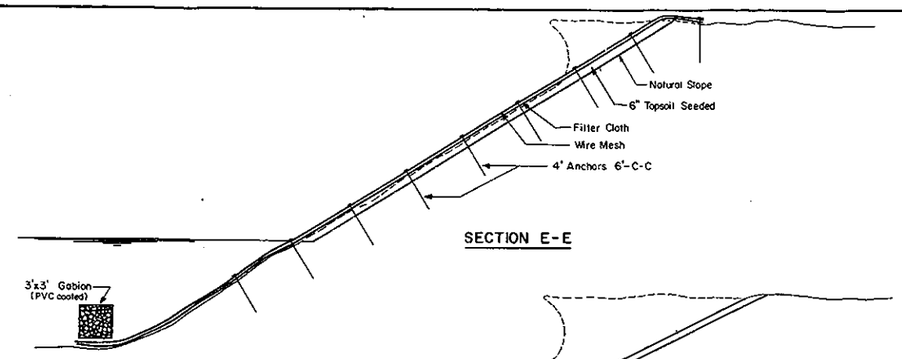
AREA 205 AND AREA 79

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

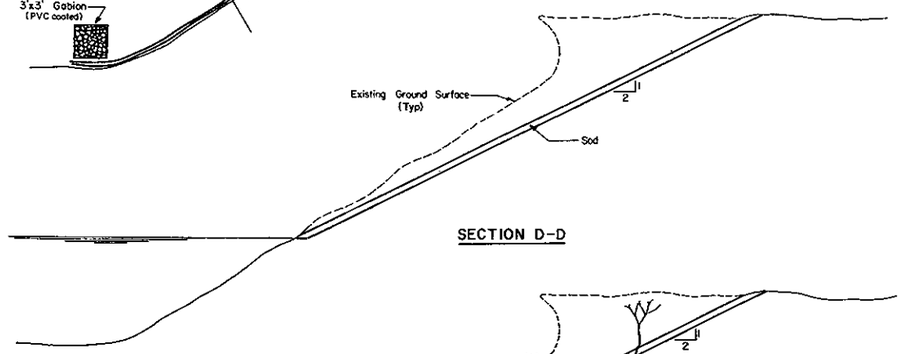
PLATE I

CORPS OF ENGINEERS

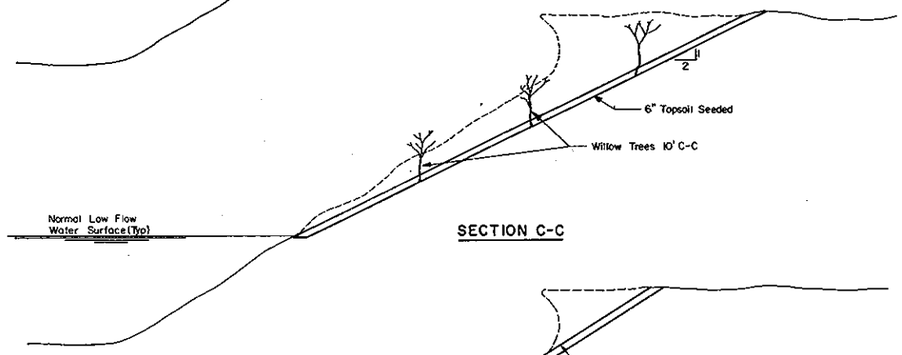
U. S. ARMY



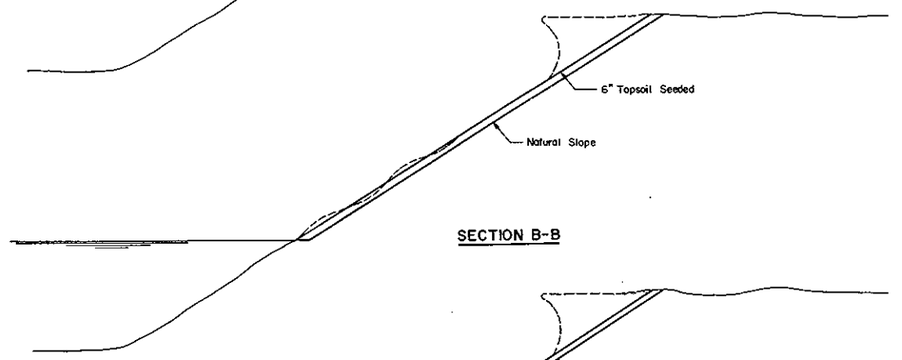
SECTION E-E



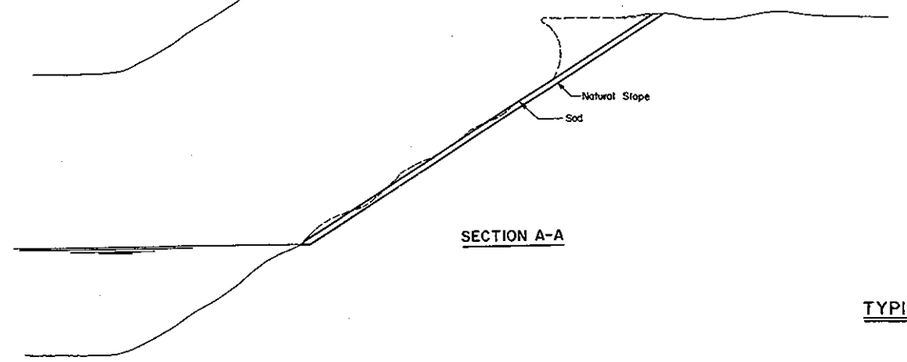
SECTION D-D



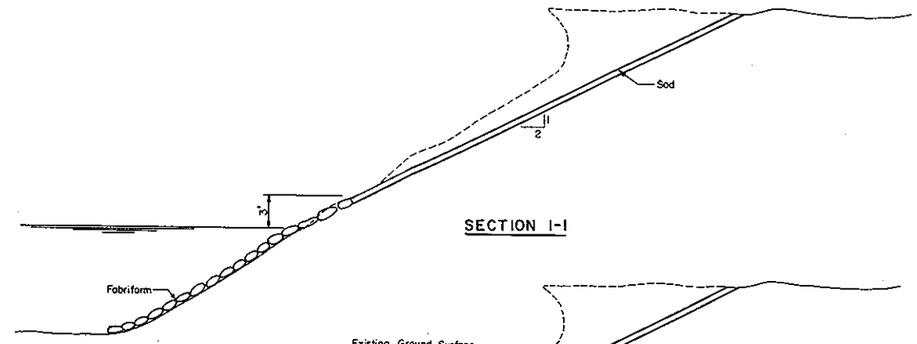
SECTION C-C



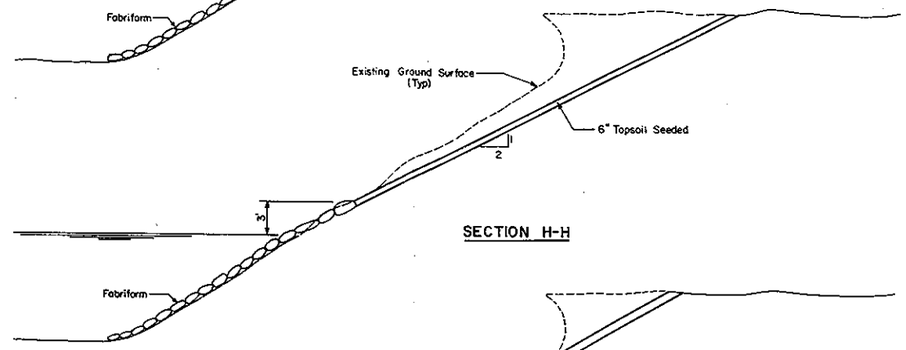
SECTION B-B



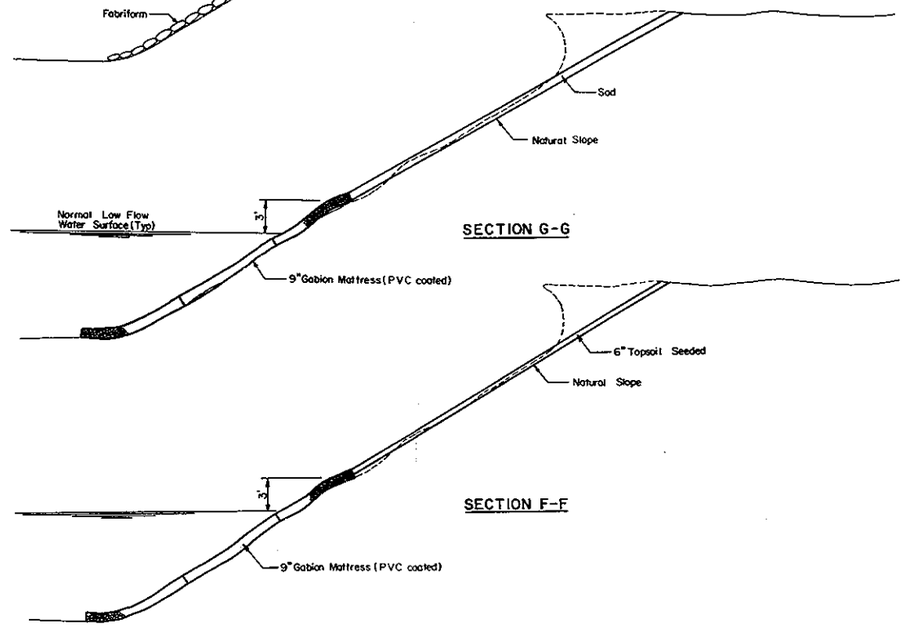
SECTION A-A



SECTION I-I



SECTION H-H



SECTION G-G

SECTION F-F

TYPICAL SECTIONS

SCALE 1"=5'-0"

GRAPHIC SCALE

1"=5' 5 0 5 10

WATER RESOURCES PILOT PROJECT
CONNECTICUT RIVER BASIN
NEW HAMPSHIRE AND MASSACHUSETTS

STREAM BANK EROSION (SECTION 32)
SECTIONS SELECTED

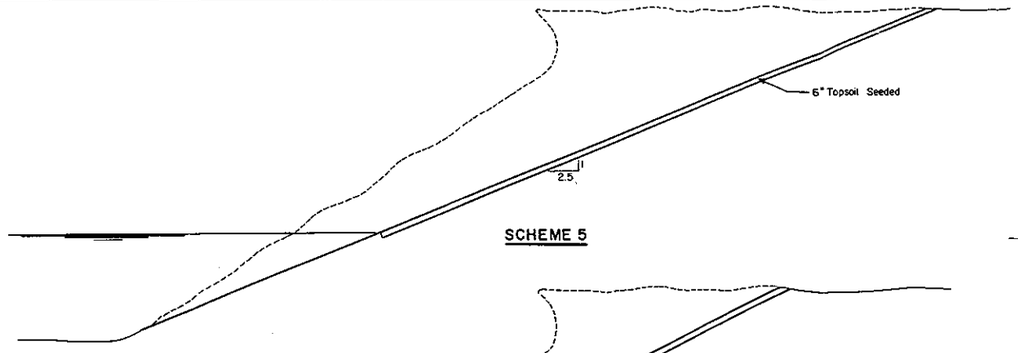
AREA 205 AND AREA 79

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

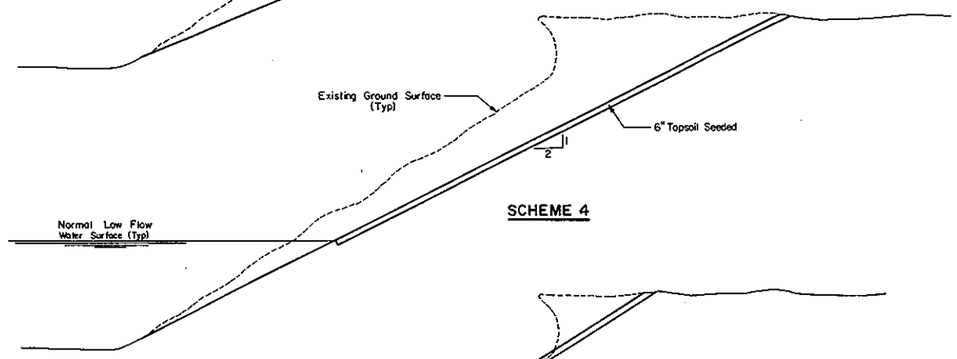
PLATE 2

CORPS OF ENGINEERS

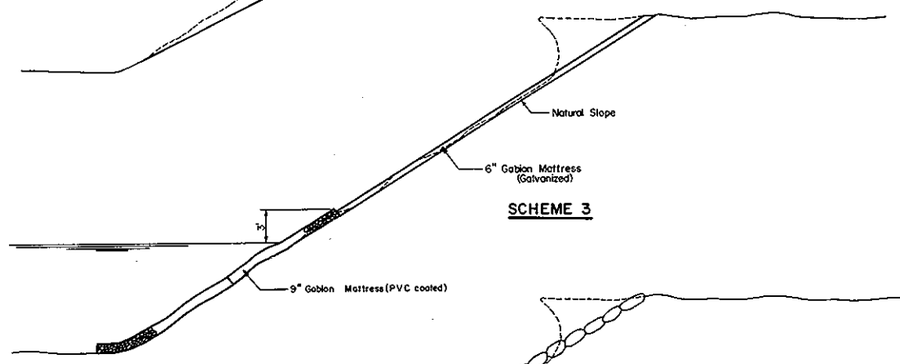
U. S. ARMY



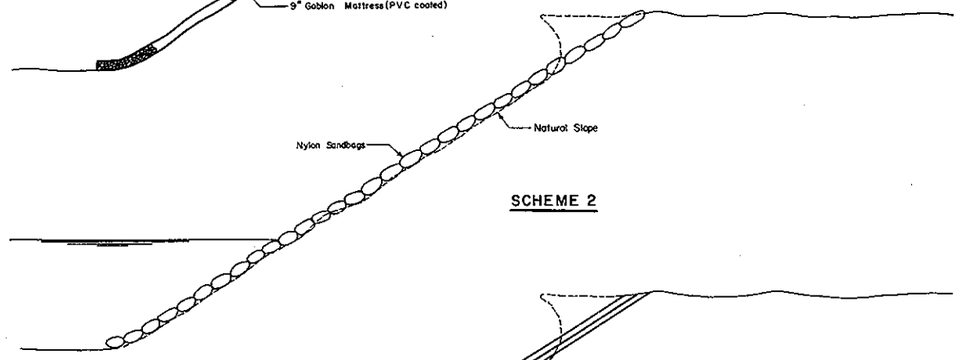
SCHEME 5



SCHEME 4



SCHEME 3



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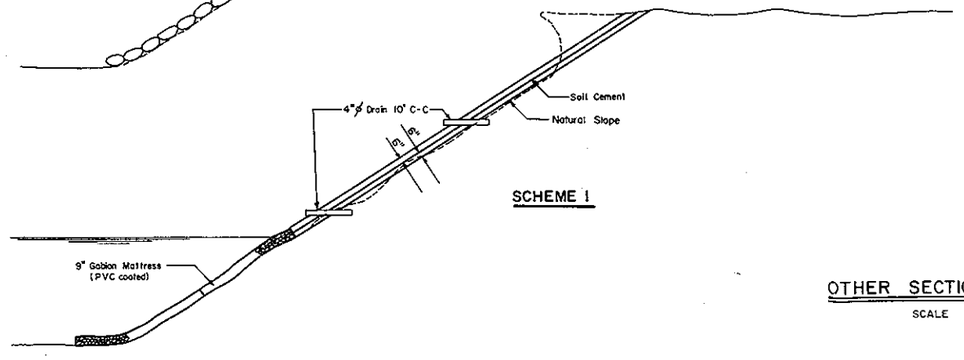
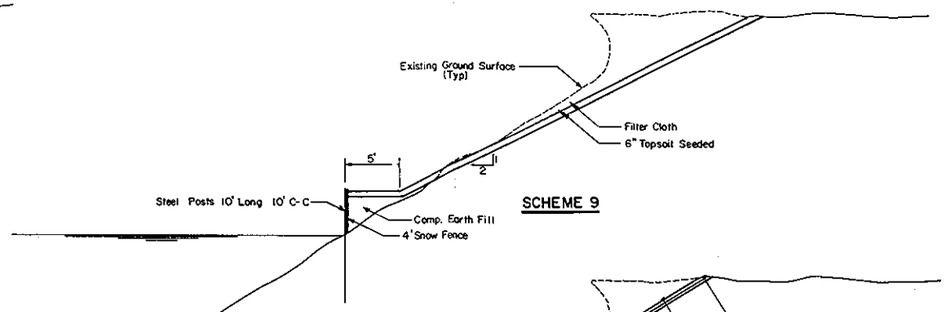


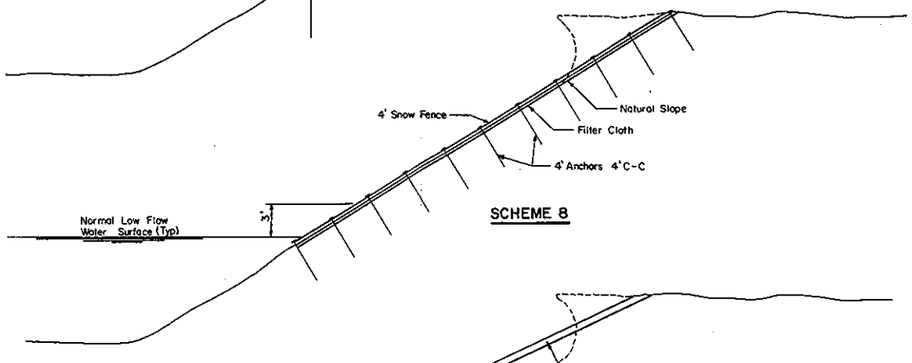
SCHEME 1

OTHER SECTIONS CONSIDERED

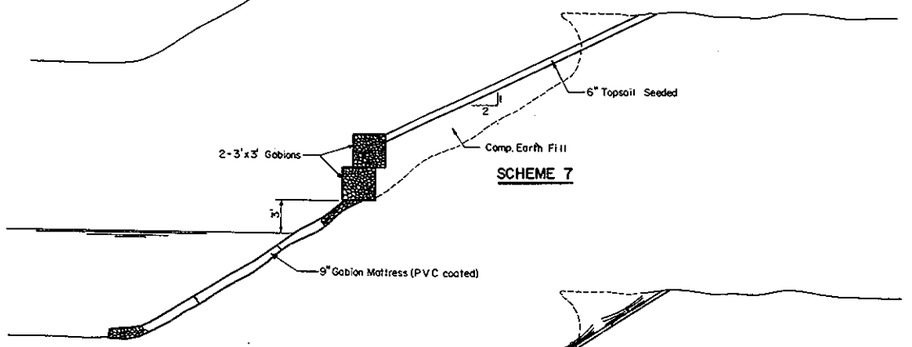
SCALE 1"=5'-0"



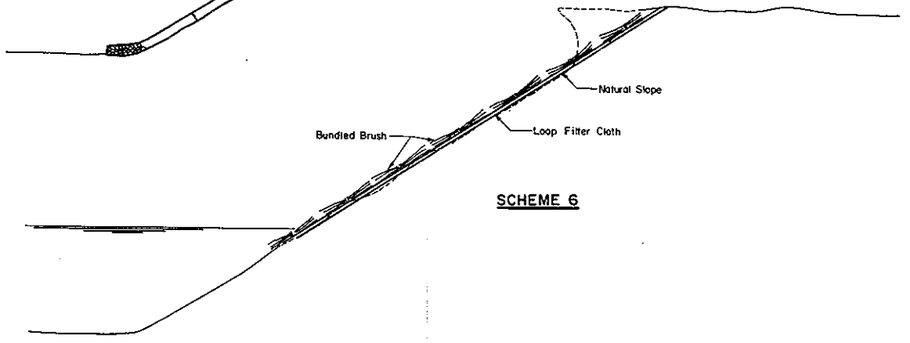
SCHEME 9



SCHEME 8



SCHEME 7



SCHEME 6

GRAPHIC SCALE

1"=5' 5 0 5 10

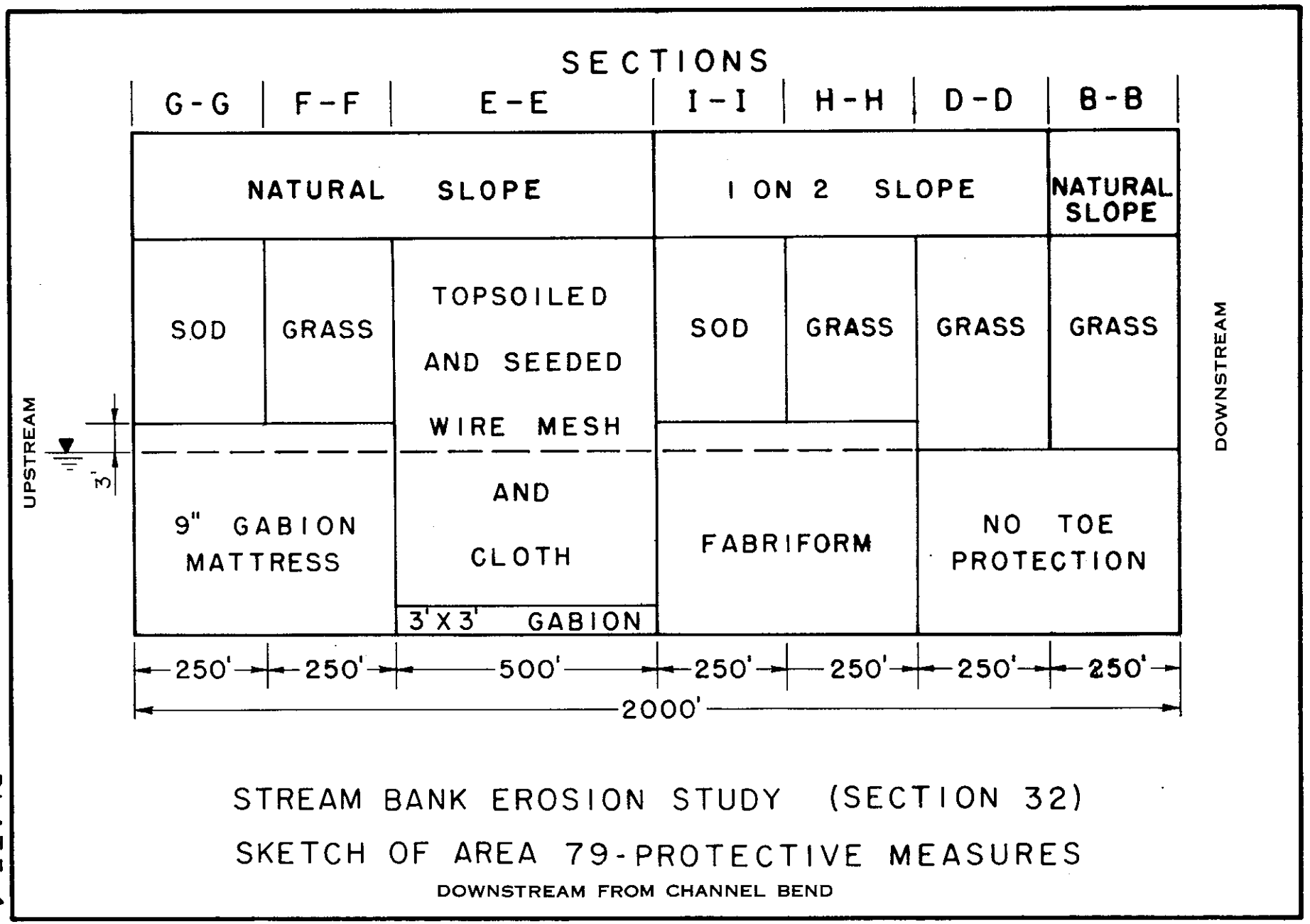
WATER RESOURCES PILOT PROJECT
CONNECTICUT RIVER BASIN
NEW HAMPSHIRE AND MASSACHUSETTS

STREAM BANK EROSION (SECTION 32)
OTHER SECTIONS CONSIDERED

AREA 205 AND AREA 79

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS

PLATE 3



STREAM BANK EROSION STUDY (SECTION 32)

SKETCH OF AREA 79-PROTECTIVE MEASURES

DOWNSTREAM FROM CHANNEL BEND

PLATE 4

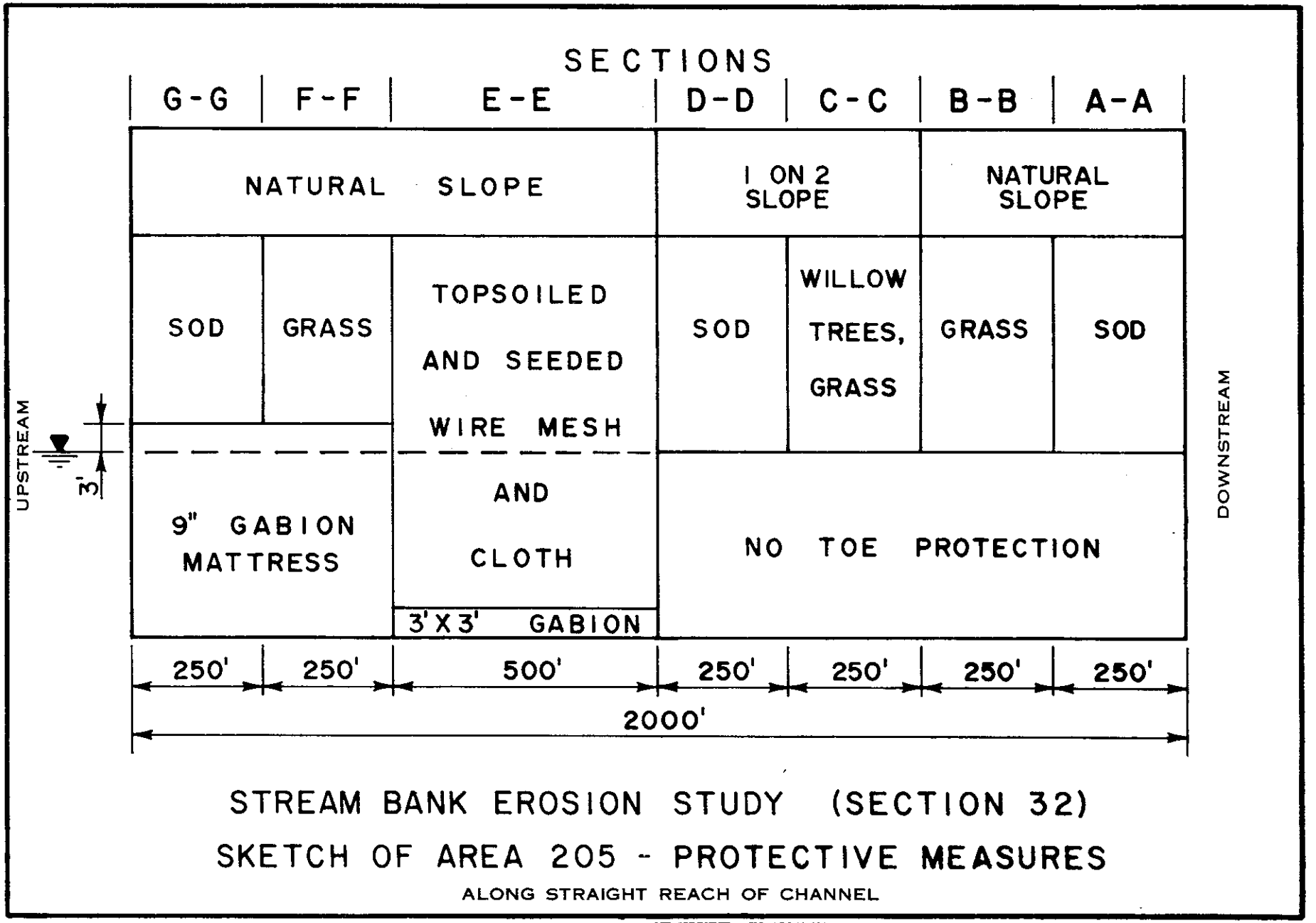


PLATE 5

STREAM BANK EROSION STUDY (SECTION 32)

SKETCH OF AREA 205 - PROTECTIVE MEASURES

ALONG STRAIGHT REACH OF CHANNEL